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Beyond National Borders: Important Mekong River Medium Sized Migratory Carps (*Cyprinidae*) and Fisheries in Laos and Cambodia

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Abstract

Many types of fish migrate up and down the Mekong River, and back and forth between the Mekong and her tributaries, adapting within a river system characterised by extreme seasonal flow variations.

This paper summarises six-years of fisheries catch-effort data regarding the artisinal dry season 4-9 cm meshed mono-filament set gill net fishery in the Mekong River just below the Khone Falls in Southern Laos, on the border with Cambodia, which targets important medium-sized migratory cyprinid carps, including *Mekongina erythrospila, Scaphognathops bandanensis, Labeo erythropterus, Bangana behri, Hypsibarbus malcolmi* and *Cirrhinus molitorella*.

The suspected migratory patterns of the main species in the fishery are described. The possibility that changes in annual catches in southern Laos are associated with the operation of bag net fisheries at the mouths of streams in northeast Cambodia is considered. The management of these straddling fish stocks, which seasonally migrate between the Mekong River in Cambodia and Laos and the Sekong, Sesan and Srepok Rivers in northeast Cambodia and southern Laos, needs to be addressed through the cooperative efforts of both countries. As a first step, joint committees of village fisher representatives and government officials from Cambodia and Laos need to begin exchanging information and discussing fisheries management issues.

Introduction

Many types of fish migrate up and down the Mekong River, and back and forth between the Mekong and her tributaries, allowing them to adapt within a river system characterised by extreme seasonal flow variations. Yet despite the importance of migrating fish to people living throughout the Mekong Basin, much remains undocumented about the nature of these migrations, or the fisheries that have developed to exploit them. Even less has been recorded about changes in fish stocks or migration patterns in response to habitat degradation or increases in fishing activities.

Various mainstream Mekong River fisheries below the Khone Falls in southern Laos are critically important to the livelihood of the local people (Roberts 1993; Roberts and Baird 1995; Baird et al. 1999; Baird 2001; Baird et al. 2001a; Baird et al. 2003) (Fig. 1). One is the dry season 4-9 cm meshed mono-filament set gill net fishery, which largely targets medium-sized migratory cyprinid carps, including *Mekongina erythrospila* Cyprinidae, *Scaphognathops bandanensis* Cyprinidae, *Labeo erythropterus* Cyprinidae, *Bangana behri* Cyprinidae, *Hypsibarbus malcolmi* Cyprinidae and *Cirrhinus molitorella* Cyprinidae. Local fishermen believe that these fishes conduct long distance dry season migrations from the Sekong, Sesan and Srepok River systems in northeast Cambodia and southern Laos to the Mekong River in northeast Cambodia, and then upriver to Laos and Thailand (Fig. 1). These migrations do not appear to be associated with lunar cycles (Baird and Flaherty, unpubl. data), as is the case with small cyprinids migrating from the Great Lake (Baird et al. 2003). Instead, changes in water levels appear to be the key to determining their timing (Baird and Flaherty, unpubl. data).

This paper presents the results of a temporal catch-effort survey for the 4-9 cm meshed set gill net fishery just below the Khone Falls, on the border with Cambodia. The data were collected for six-years between 1993 and 1998. The complicated migration patterns of fishes moving from the Sekong, Sesan and Srepok are described and discussed, and changes in the relative abundances of fishes in catches are considered. We provide preliminary ideas about whether illegal stream-blocking bag net fisheries in

Fig. 1. The study area in the context of the lower Mekong River Basin

northeast Cambodia have an impact on some of the fish populations targeted by the gill net fisheries in southern Laos, creating a potentially important international fisheries management issue. The potential impacts of large dam construction on migrating fish species important to the gill net fisheries are also discussed.

Materials and Methods

Between March 1993 and May 1999, a total of 22 artisinal fishers and their immediate families from Hang Khone Village, Khong District, Champasak Province, southern Laos had their fish catches monitored by the first author and his Lao colleagues. Hang Khone is an important, yet small, fishing community located on the southern end of Khone Island, which is in the mainstream Mekong River, just below the Khone Falls, on the border with Cambodia (Fig. 2). Fishermen were asked to supply information regarding the types of fishing gears they use, the quantities of gears set, and the time-spent in fishing. They were also requested to allow us to observe, identify, count, weigh and sometimes record lengths of the fish caught. Since all the fishermen moored their boats at the same general location, it was possible to observe all their fish as they were brought up the riverbank to the fishers' houses and past the location where we collected data. This made it possible for the fish to be weighed fresh on a daily basis. This fisheries data collection program was one of the most important efforts of its kind in the Mekong River basin. Data was collected continuously for a number of fisheries over many years, also (Roberts and Baird 1995; Baird et al. 2001a and b; Baird et al. 2003). However, this paper addresses just one of the important fisheries at Hang Khone, the dry season 4-9 cm meshed mono-filament set nylon gill net fishery used to target medium-sized migratory carps, which mainly occur between December and January.

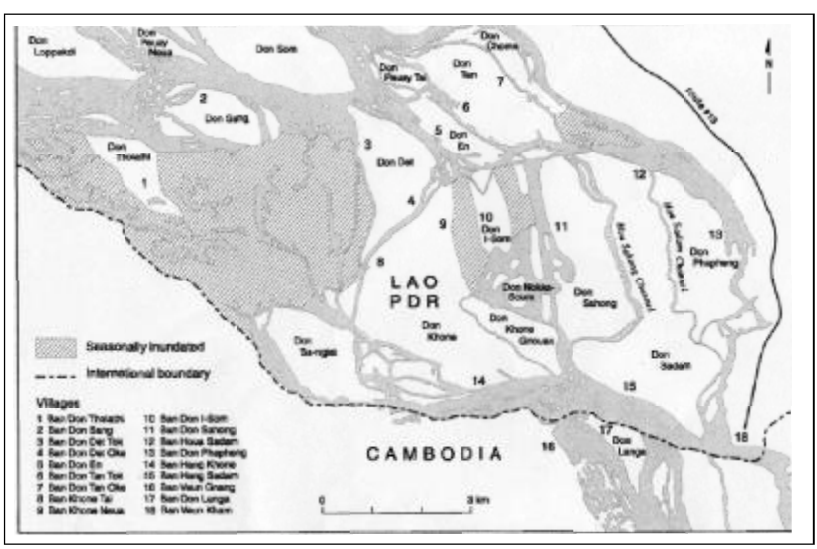

Fig. 2. The Khone Falls area, Khong District, Champasak Province, Southern Lao PDR

The 4-9 cm meshed mono-filament nylon gill nets used to target *Scaphognathops bandanensis, Mekongina erythrospila* and a number of other medium sized cyprinids at Hang Khone are generally sold in bundles, which fishers string and weigh themselves. Uncut gill nets, after stringing, are generally 91 m long. The length of the float line along the top of the net determines the net's hanging length. The average mesh size for the fishery is approximately 6 cm, with 4, 5, 6, 7, 8 and 9 cm being used. Gill nets used are generally 50 meshes deep before cutting. One additional full mesh is generally woven onto the bottom of the gill nets using heavier line in order to weigh down the bottom of the net. Small metal weights are added to the bottom of the nets at intervals, to help weigh the lower part of the nets down. The uncut nets are therefore 51 meshes deep with depths of about 3.06 m (51 meshes x 6 cm) when fully stretched, and 2.04 m (51 meshes x 4 cm) when hanging in the water. The total net area for a hanging 6 cm mesh size uncut gill net that is 91 m long is thus 185.64 m^2.

However, bundles of nets are usually cut into pieces before use, and cutting differs depending on the fisherman, and fish locations. Narrow sites require short nets, while shallow areas need shallow nets. All but one of the fishermen whose catches were monitored at Hang Khone cut their 4-9 cm meshed nets before stringing and using them. Some reported cutting them in half, while others cut single pieces into four nets. A full net is cut once width wise and another time length wise. One fisherman reported making two bundles into five nets. However, the typical fisherman uses one bundle to make three gill nets, and the average hanging net area for the gill nets after cutting and stringing is estimated at 62 m^2.

Data on catches were collected every day during the season, sometimes a number of times per day if landings were good. Catch-per-unit-effort (CPUE), however, has been calculated based on average catches over one-week periods in order to make data easier to present. The CPUE levels are based on the catch of single nets used over 12 hour periods.

This study combines both quantitative and qualitative data. On the qualitative side, Local Ecological Knowledge (LEK) held by fishers is an extremely important resource, especially when combined with quantitative fisheries data based on extensive fishery catch data, as is the case here.

Results

Table 1 presents the total catch summaries by species and weight from 1993/94 to 1998/99 using 4-9 cm set mono-filament gill net fishing seasons at Hang Khone. Table 2 combines the results of the six seasons. At least 104 species of fish and one species of crustacean (*Macrobrachium* sp.) were recorded in catches over the six years; 201 fish species have been recorded as occurring in the Khone Falls area (Baird 2001).

The cyprinid carp *Scaphognathops bandanensis* was the most abundant species in catches by weight over the six years, making up at least 28.7% of the landings, and probably about 34% because in 1993/1994, *S. bandanensis*

Table 1. Summaries of 1993-1998 catches by year for the 4-9 cm meshed gillnet fishery at Hang Khong Village, Khong District, Champasak Province, Southern Lao PDR

#	Latin Name	T_weight (g)	% catch	Min (g)	Max (g)	Mean (g)	StDev (g)
	1993						
1	*Scaphognathops spp.*	136,655	61.53	20	289	91	50
2	*Mekongina erythrospila*	15,870	13.87	110	331	192	82
3	*Cosmochilus harmandi*	5,960	8.32	20	500	156	113
4	*Morulius chrysophekadion/spp.*	2,550	2.61	358	400	379	29
5	*Cirrhinus microlepis*	2,370	2.32	400	493	446	65
6	*Hemibagrus filamentous*	2,345	1.55	100	1,200	335	391
7	*Euryglossa panoides*	1,880	1.44	100	198	151	30
8	*Cyclocheilichthys armatus*	855	1.22	55	500	158	192
9	*Boesemania microlepis*	855	0.73	25	180	93	53
10	*Cyclocheilichthys enoplos*	820	0.68	70	150	114	32
11	Others (20 species)	6,920	3.91				
	Totals	177,090	100.00				
	1994						
1	*Scaphognathops bandanensis*	344,228	52.39	18	386	78	37
2	*Mekongina erythrospila*	114,060	17.36	36	583	167	75
3	*Miscellaneous fish spp.*	39,000	5.94				
4	*Labeo erythropterus*	27,600	4.20	75	1,500	245	194
5	*Cosmochilus harmandi*	24,610	3.75	50	685	160	95
6	*Hypsibarbus malcolmi*	15,040	2.29	30	270	127	49
7	*Cirrhinus microlepis*	13,845	2.11	110	510	171	112
8	*Gyrinocheilus pennocki*	11,480	1.75	40	360	106	54
9	*Bangana behri*	10,770	1.64	80	1,350	239	268
10	*Pangasius polyuranodon*	10,580	1.61	90	430	193	81
11	Others (66 species)	45,848	6.98				
	Totals	657,061	100.00				
	1995						
1	*Mekongina erythrospila*	112,517	31.08	13	390	148	51
2	*Scaphognathops bandanensis*	69,551	19.21	25	260	71	39
3	*Cosmochilus harmandi*	32,445	8.96	35	550	156	98
4	*Labeo erythropterus*	13,875	3.83	70	500	234	109
5	*Hypsibarbus malcolmi*	13,195	3.64	50	950	152	168
6	*Gyrinocheilus pennocki*	12,090	3.34	20	185	100	39
7	*Pangasius polyuranodon*	12,025	3.32	50	345	174	71
8	*Puntioplites falcifer*	11,390	3.15	30	200	77	31
9	*Bangana behri*	7,225	2.00	45	195	102	40
10	*Cyclocheilichthys enoplos*	6,367	1.76	50	650	164	132
11	Others (63 species)	71,375	19.71				
	Totals	362,055	100.00				
	1996						
1	*Mekongina erythrospila*	163,950	29.09	50	1,200	213	163
2	*Scaphognathops bandanensis*	150,875	26.77	10	533	113	64
3	*Cosmochilus harmandi*	62,345	11.06	37	1,500	220	196
4	*Euryglossa panoides*	26,820	4.76	40	310	166	64
5	*Labeo erythropterus*	16,545	2.94	60	1,050	208	152
6	*Hypsibarbus malcolmi*	15,310	2.72	55	750	175	137
7	*Gyrinocheilus pennocki*	10,565	1.87	35	217	101	43
8	*Hemibagrus filamentous*	10,135	1.80	50	800	203	162
9	*Boesemania microlepis*	9,005	1.60	50	1,350	409	360
10	*Cyclocheilichthys enoplos*	8,930	1.58	70	1,400	280	320
11	Others (60 species)	89,160	15.82				
	Totals	563,640	100.00				
	1997						
1	*Scaphognathops bandanensis*	145,930	27.67	20	800	121	81
2	*Mekongina erythrospila*	112,785	21.38	25	2,500	293	336
3	*Cosmochilus harmandi*	47,320	8.97	50	3,000	392	446
4	*Gyrinocheilus pennocki*	42,930	8.14	35	400	153	130
5	*Labeo erythropterus*	38,240	7.25	50	1,100	344	244
6	*Morulius spp.*	21,840	4.14	90	1,300	443	329
7	*Hemibagrus filamentous*	12,295	2.33	50	750	254	157
8	*Hypsibarbus malcolmi*	12,195	2.31	14	1,000	249	227
9	*Boesemania microlepis*	7,430	1.41	60	3,000	378	682
10	*Puntioplites falcifer*	6,425	1.22	45	300	174	83
11	Others (52 species)	80,022	15.17				
	Totals	527,412	100.00				
	1998						
1	*Mekongina erythrospila*	168,600	61.63	79	900	204	111
2	*Cosmochilus harmandi*	37,930	13.87	28	600	226	124
3	*Scaphognathops bandanensis*	22,750	8.32	44	300	133	57
4	*Gyrinocheilus pennocki*	7,150	2.61	50	400	197	117
5	*Labeo erythropterus*	6,350	2.32	100	600	277	172
6	*Hypsibarbus malcolmi*	4,240	1.55	80	300	146	62
7	*Cyclocheilichthys enoplos*	3,950	1.44	90	500	258	144
8	*Boesemania microlepis*	3,330	1.22	80	300	147	73
9	*Probarbus jullieni*	2,000	0.73	200	800	500	245
10	*Pangasius polyuranodon*	1,870	0.68	100	600	224	171
11	Others (23 species)	15,380	5.62				
	Totals	273,550	100.00				

Table 2. Summary of total 1993-1998 catches for the 4-9 cm meshed gillnet fishery at Hang Khong Village, Khong District, Champasak Province, Southern Lao PDR

#	Latin Name	Lao Name	T_weight (g)	% catch	Min (g)	Max (g)	Mean (g)	StDev (g)
1	*Scaphognathops bandanensis*	*pa pian*	734,014	28.66	20	800	100	63
2	*Mekongina erythrospila*	*pa sa-I*	687,782	26.86	13	2,500	211	195
3	*Cosmochilus harmandi*	*pa mak ban*	210,610	8.22	20	3,000	221	230
4	*Scaphognathops spp.*	*pa pian*	137,065	5.35	20	289	93	50
5	*Labeo erythropterus*	*pa va souang*	102,610	4.01	50	1,500	265	196
6	*Gyrinocheilus pennocki*	*pa ko*	84,215	3.29	20	400	123	89
7	*Hypsibarbus malcolmi*	*pa pak kom*	60,420	2.36	14	1,000	162	148
8	*Miscellaneous fish spp.*	*N/A*	39,000	1.52				
9	*Hemibagrus filamentous*	*pa kot leuang*	37,150	1.45	35	1,200	206	167
10	*Pangasius polyuranodon*	*pa gnone hang hian*	34,525	1.35	20	600	166	82
11	*Euryglossa panoides*	*pa pan gnai*	32,610	1.27	10	350	170	74
12	*Morulius chrysophekadion/spp.*	*pa phia*	32,180	1.26	60	1,300	421	333
13	*Bangana behri*	*pa va na no*	29,935	1.17	35	1,350	166	180
14	*Puntioplites falcifer*	*pa sakang*	29,365	1.15	23	300	91	57
15	*Cirrhinus microlepis*	*pa phone*	28,225	1.10	100	1,500	452	434
16	*Cyclocheilichthys enoplos*	*pa chok*	25,952	1.01	50	1,500	234	247
17	*Boesemania microlepis*	*pa kouang*	24,490	0.96	20	3,000	235	376
18	*Cirrhinus molitorella*	*pa keng*	17,390	0.68	50	2,150	221	316
19	*Parambassis wolffi/spp.*	*pa khap khong*	12,605	0.49	10	400	55	40
20	*Helicophagus waandersi*	*pa nou/pa hoi*	12,075	0.47	45	1,000	195	176
21	*Probarbus jullieni*	*pa eun ta deng*	11,505	0.45	67	1,500	327	299
22	*Hemibagrus wycki*	*pa kot mo*	10,180	0.40	90	1,200	313	272
23	*Hemisilurus mekongensis*	*pa nang deng*	9,430	0.37	35	750	205	130
24	*Belodontichthys dinema*	*pa khop*	9,400	0.37	50	1,250	287	296
25	*Micronema apogon/micronema*	*pa nang khao/ pa sangoua*	9,050	0.35	5	550	160	114
26	*Pangasius pleurotaenia*	*pa gnone thong khom*	8,345	0.33	43	170	98	35
27	*Polynemus longipectoralis*	*pa chin*	8,075	0.32	20	250	103	52
28	*Amblyrhynchichthys truncatus*	*pa ta po*	7,260	0.28	25	275	90	48
29	*Bagarius yarrelli/spp.*	*pa khe*	7,245	0.28	65	1,115	341	304
30	*Cyclocheilichthys armatus*	*pa doke ngieu*	6,850	0.27	6	500	83	58
31	*Scaphognathops stejnegeri*	*pa pian*	6,035	0.24	5	700	110	105
32	*Chitala blanci*	*pa tong kai*	5,115	0.20	45	700	215	155
33	*Labiobarbus leptocheilus*	*pa lang khon*	4,940	0.19	30	167	74	34
34	*Pangasius conchophilus*	*pa pho/pa ke*	4,705	0.18	45	300	126	68
35	*Hemipimelodus borneensis*	*pa khat ok*	4,140	0.16	10	250	63	38
36	*Barbodes altus*	*pa vian fai*	3,980	0.16	40	200	92	45
37	*Notopterus notopterus*	*pa tong na*	3,975	0.16	45	300	115	52
38	*Amphotistius laosensis*	*pa fa lai/pa fa hang*	3,885	0.15	100	2,100	971	831
39	*Bagrichthys macracanthus*	*pa mak khan mak kheu*	3,580	0.14	45	350	117	71
40	*Channa marulius/spp.*	*pa kouan*	3,345	0.13	50	1,650	319	519
41	*Himantura chaophraya*	*pa fa lai/pa fa hang*	3,000	0.12	3,000	3,000	3,000	
42	*Pangasius macronema*	*pa gnone thamada*	2,970	0.12	10	200	81	50
43	*Coius undecimradiatus*	*pa seua*	2,960	0.12	70	448	252	146
44	*Hypsibarbus wetmorei*	*pa pak thong leuang/ pa pak kham*	2,875	0.11	35	1,000	292	312
45	*Mystus singaringan/spp.*	*pa kha gneng*	2,725	0.11	50	167	82	32
46	*Bagrichthys macropterus*	*pa kouay souk*	2,635	0.10	60	250	129	55
47	*Lobocheilos melanotaenia*	*pa khiang*	2,580	0.10	30	140	55	21
48	*Tenualosa thibaudeaui*	*pa mak phang*	2,235	0.09	25	250	67	50
49	*Channa striata*	*pa kho*	2,000	0.08	550	900	667	202
50	*Cynoglossus microlepis*	*pa lin ma*	1,970	0.08	70	200	109	34
51	*Mystacoleucus marginatus*	*pa lang ko*	1,875	0.07	10	170	37	30
52	*Chitala ornata*	*pa tong khouay*	1,650	0.06	200	550	413	155
53	*Kryptopterus spp.*	*pa pik kai*	1,650	0.06	20	100	57	18
54	*Hypsibarbus lagleri*	*pa pak pay*	1,550	0.06	50	500	221	149
55	*Osteochilus melanopleurus*	*pa nok khao*	1,545	0.06	50	300	127	83
56	*Probarbus labeamajor*	*pa eun khao*	1,445	0.06	100	350	241	105
57	*Pangasianodon hypophthalmus*	*pa souay kheo*	1,410	0.06	60	750	470	363
58	*Cyclocheilichthys apogon*	*pa doke ngieu*	1,380	0.05	38	400	198	154
59	*Hemibagrus wyckioides*	*pa kheung*	1,290	0.05	100	500	215	165
60	*Thynnichthys thynnoides*	*pa koum*	1,270	0.05	65	160	94	29
61	*Henicorhynchus siamensis*	*pa soi houa po*	1,245	0.05	10	100	55	21
62	*Hampala macrolepidota*	*pa sout*	1,125	0.04	100	600	225	211
63	*Sikukia gudgeri*	*pa khao na*	1,110	0.04	30	150	74	36
64	*Ompok bimaculatus*	*pa seuam*	1,100	0.04	50	110	78	21
65	*Cyclocheilichthys repasson*	*pa doke ngieu*	1,050	0.04	200	250	225	35
66	*Micronema bleekeri*	*pa nang ngeun*	975	0.04	70	500	325	226
67	*Mastacemblus armatus/spp.*	*pa lat*	875	0.03	25	280	146	104
68	*Leptobarbus hoeveni*	*pa phong*	860	0.03	860	860	860	
69	*Pangasius sanitwongsei*	*pa leum*	815	0.03	50	150	102	39
70	*Raiamas guttatus*	*pa sanak*	715	0.03	70	160	119	37
71	*Pseudomystus siamensis*	*pa khi hia*	700	0.03	20	90	47	17
72	*Achiroides spp.*	*pa pan*	695	0.03	15	150	68	50
73	*Onychostoma cf. elongatum*	*pa khiang fai*	490	0.02	35	210	98	78
74	*Arius stormi*	*pa khat ok*	440	0.02	200	240	220	28
75	*Rhinogobius spp.*	*pa bou*	400	0.02	40	180	100	71

continued...

Table 2 continued...

#	Latin Name	Lao Name	T_weight (g)	% catch	Min (g)	Max (g)	Mean (g)	StDev (g)
76	*Pangasius bocourti*	*pa houa mouam*	398	0.02	40	108	80	32
77	*Macrognathus siamensis/spp.*	*pa lot*	320	0.01	20	300	160	198
78	*Poropuntius deauratus*	*pa chat*	250	0.01	50	110	83	31
79	*Macrochirichthys macrochirus*	*pa hang pha*	205	0.01	100	105	103	4
80	*Machrobrachium sp. (lg. Shrimp)*	*koung gnai*	200	0.01	200	200	200	
81	*Aaptosyax grypus*	*pa sanak gnai*	200	0.01	100	100	100	
82	*Henicorhynchus lineatus*	*pa soi lai*	200	0.01	200	200	200	
83	*Setipinna melanochir*	*pa meo*	195	0.01	20	50	39	12
84	*Botia modesta*	*pa mou*	195	0.01	45	150	98	74
85	*Osteochilus microcephalus/ waandersii*	*pa khang lai gnai*	190	0.01	50	70	63	12
86	*Toxotes microlepis*	*pa mong*	170	0.01	170	170	170	
87	*Luciosoma bleekeri*	*pa mak vai*	160	0.01	80	80	80	0
88	*Oxyeleotris marmorata*	*pa bou*	155	0.01	40	75	52	20
89	*Cirrhinus jullieni*	*pa doke ngieu pha*	150	0.01	150	150	150	
90	*Hypsibarbus pierrei*	*pa pak ta leuang*	130	0.01	65	65	65	
91	*cf. Systomus sp.*	*pa khao*	120	0.00	120	120	120	
92	*Wallago leeri*	*pa khoun*	110	0.00	110	110	110	
93	*Cirrhinus mrigala*	*pa nang chan*	95	0.00	95	95	95	
94	*Osteochilus hasselti*	*pa khi ka pheuay*	90	0.00	10	80	45	49
95	*Osteochilus waandersii*	*pa khang lai gnai*	80	0.00	80	80	80	
96	*Pristolepis fasciata*	*pa ka*	70	0.00	30	40	35	7
97	*Osphronemus exodon*	*pa men*	55	0.00	55	55	55	
98	*Anabas testudineus*	*pa kheng*	50	0.00	50	50	50	
99	*Tetraodon leiurus/spp.*	*pa pao*	50	0.00	50	50	50	
100	*Acantopsis sp.or spp.*	*pa hak kouay*	45	0.00	45	45	45	
101	*Paralaubuca typus*	*pa tep*	27	0.00	12	15	14	2
102	*Osteochilus lini*	*pa soi*	20	0.00	20	20	20	
103	*Opsarius koratensis*	*pa lai khouang*	10	0.00	10	10	10	
	Totals		2,560,808	100.00				

and the closely related species *Scaphognathops stejnegeri* Cyprinidae were lumped together as '*Scaphognathops* spp.'. *Scaphognathops bandanensis* catches ranged from over 77% of the total landings in 1993/94 to 8.3% of harvests by weight in 1998/99. However, the catches of this highly migratory species (Warren et al., 1998) dropped dramatically compared to other species during the course of the study.

The carp *Mekongina erythrospila*, another highly migratory species (Baird et al. 1999), was the second most abundant species caught, accounting for almost 27% of catches for the six seasons. This species made up nine percent of catches in 1993/94 but its relative abundance increased to 61.6% in 1998/99. *M. erythrospila* was the most abundant species in 1995/96, 1996/97, and 1998/99 (three out of the last four years that the fishery was monitored).

The carp *Cosmochilus harmandi* S. was the third most abundant fish, making up 8.2 percent of landings, or between 3.4 and 13.9% for individual years. Not believed to be highly migratory, it is caught in relatively large quantities in several nearby fisheries year round, for example (Baird 1998). However, *C. harmandi* probably undertakes localised movements in response to hydrological changes (Roberts and Baird 1995).

The carp *Labeo erythropterus* was the fourth most abundant fish, making up just over four percent of catches for the six years, or between no fishes in 1993/94 to 7.3 percent of catches in 1997/98. Only small and medium sized individuals of this migratory species were caught (Baird et al. 1999).

The fifth most abundant species was *Gyrinocheilus pennocki* Gyrinocheilidae, which made up 3.3 percent of catches, or between no fish in 1993/94 and 8.1 percent in 1997/98, and was the most abundant non-cyprinid in catches. However, because in 1993/94 the fishery was only monitored until January 10, *G. pennocki* were certainly caught in that year, but only after our monitoring efforts ended. The species is suspected to be highly migratory (Roberts and Baird 1995; Baird et al. 1999).

The barb *Hypsibarbus malcolmi* was the sixth most abundant species, making up 2.4 percent of catches, or between 0.3 and 3.6 percent for individual years. This species is believed to be migratory (Baird et al. 1999)

The catfish *Hemibagrus filamentous* Siluridae *(Mystus nemurus*) was the seventh most abundant, making up 1.5 percent of overall landings, or between 1.3 and 2.3 percent for a given year. Not believed to migrate long distances up and down the Mekong River, it does migrate between tributaries in the wet season, where it spawns, and larger rivers in the dry season (Baird, unpubl. data; Baird et al. 1999; Poulsen and Jorgensen 2000).

The catfish *Pangasius polyuranodon* Pangasiidae was the eighth most abundant, making up 1.4 percent of catches, or between 0.4 and 3.3 percent for individual years. It is not believed to be migrating when caught in this fishery, as it is landed in several local fisheries year round (Baird et al. 1999).

The large freshwater sole *Euryglossa panoides* Solidae is the ninth most abundant fish species, making up 1.3% of the catch, or between none and 4.8% for individual years. This species is not found above the Khone Falls, which is a biogeographical barrier to its upriver movements (Roberts 1993). It is not known to be migratory (Baird et al. 1999).

The tenth most abundant species is the carp *Morulius* spp. Cyprinidae, which made up 1.3% of catches, or between no fish in 1998/99 to 4.1% in 1997/98. The two species probably conduct seasonal migrations between the Mekong River and small tributaries. *Morulius* sp. or spp. also reportedly migrate up the Mekong River past Kratie, in northeast Cambodia, in January and February (Roberts and Warren 1994). Poulsen and Jorgensen (2000) reported that fishers believe that the species migrate up the Mekong River between March and August. However, some apparently remain in the mainstream Mekong all year (Baird et al. 1999). It is difficult to confirm whether the fish caught at Hang Khone are migrating, as there is not any clear evidence of migratory behavior.

The carp *Bangana behri* was the 11th most abundant, making up 1.2% of landings, or between none and two percent during individual years. It is believed to be highly migratory (Baird et al. 1999).

The carp *Puntioplites falcifer* Cyprinidae is the 12th most abundant, making up 1.2% of the landings, or from 0.3 to 3.2% in individual years. It migrates relatively long distances in some cases, and short distances in others, moving laterally into medium to large tributaries in the rainy season, before reentering large rivers in the dry season (Baird et al. 1999; Poulsen and Jorgensen 2000). Villagers report that in July and August it can be caught in streams with water about one meter deep, although this is only

possible for a three or four-day period after water levels temporarily go down due to lapses in rainfall. Other species, such as *Hypsibarbus malcolmi, Scaphognathops bandanensis, Hemibagrus filamentous* and *Hemibagrus wyckioides* Siluridae apparently exhibit similar behavior (Baird et al. 1999).

The carp *Cirrhinus microlepis* Cyprinidae is the 13th most abundant, making up 1.1% of landings, or between no fish in 1998/99 to 2.1% in 1994/95. It was also found to be particularly abundant in fence-filter *(tone)* traps used in the Khone Falls in early 1995 (Baird et al. 2003), and is the sixth most abundant species in the bag net fishery in the Tonle Sap River in Cambodia in the same year, which was considered an exceptionally good year for the species (Lieng et al. 1995). *C. microlepis* is apparently highly migratory (Baird et al. 1999; Poulsen and Jorgensen 2000).

The carp *Cyclocheilichthys enoplos* Cyprinidae is the 14th most abundant, making up one percent of landings, or between 0.1% in 1994/95 to 1.8% in 1995/96. Individuals appear to migrate upriver two times a year. In January and February, smaller individuals swim upriver, and at the beginning of the rainy season, larger individuals move up (Baird et al. 1999).

The freshwater croaker *Boesemania microlepis* Sciaenidae also made up one percent of catches, or between 0.3% and 1.6% for individual years. It is the 15th most abundant species, and is not believed to be highly migratory. It probably stays in the Hang Khone area year round, where it vocalises and spawns in the dry season (Baird et al. 2001b).

The carp *Cirrhinus molitorella* accounted for only 0.7% of landings, making it the 16th most abundant species. Nevertheless, it is believed to be highly migratory (Roberts and Baird 1995; Singhanouvong et al., unpubl. data; Warren et al. 1998). It is never caught in Hang Khone outside of the migration season (Baird, unpubl. data; Baird et al. 1999).

Table 3 includes a list of fish species reported to be caught each year in large stream bag nets *(ouan)* situated at the mouths of substantial streams running into the Mekong, Sekong, Sesan and Srepok Rivers in northeast Cambodia. Species have been ranked according to their relative abundances in catches, and have been classified by the stages they left the streams to return to the larger rivers. This information was provided to the first author in August 1997 by a group of ethnic Lao fishermen who have, for many years, run and worked on various stream bag net fishing operations at the mouths of large streams in Stung Treng Province. They used their LEK of Kaliang stream, which is in Siam Pang District, Stung Treng Province, as the basis for the information provided, but emphasised that other streams in the province had similar assemblages of fish. The fishermen reported that in recent years catches from Kaliang stream have dropped from about ten tonnes a season when the fishery was first established to just three tonnes a season, less than ten years later. *Hemibagrus filamentous* is the species caught most by weight, with *Hypsibarbus malcolmi* and *Hypsibarbus lagleri* Cyprinidae together being the second most abundant. *Scaphognathops bandanensis* was the third most common, followed by *Puntioplites falcifer* and *Morulius* sp. or spp., and then others.

The data included in table 3 are based on interviews in which fishermen were asked to identify the main fish species and migration periods, rather than all the minor species. The data were not meant to provide a definitive assessment of the stream bag net fishery, since no other quantitative data regarding the illegal stream bag net fisheries exists. However, table 3 does provide some important information for assessing fish stocks targeted at Hang Khone by 4-9 cm meshed set gill nets. For illegal fisheries like the bag net fishery in northeast Cambodia, it is sometimes necessary to rely on qualitative fisheries data.

Figure 3 indicates that the fishery begins between around the middle and the end of December. The main peak in catches generally continues for between a few days and over a week, and then drops off at the end of December or very early in January. However, the overall fishery may continue for a number of months with low level catches (Baird and Flaherty, unpubl. data).

Cosmochilus harmandi is caught consistently throughout each season in low numbers, and does not appear to be migrating at this time of year. *Labeo erythropterus*, however, is probably migratory, but carries out more protracted migrations than other species. *Hypsibarbus malcolmi* appears to

Table 3. Fish species reportedly caught in stream bag nets in Northeast Cambodia, the periods of catches, and a ranking of species contribution to total catch by weight

#	Latin Name	Local Lao Name	Period Caught	Notes
1	*Hemibagrus filamentous*	*pa kot leuang*	1st	No *H. wycki* reported
2	*Hypsbarbus malcolmi*	*pa pak kom*	2nd	No *H. wetmorei* reported
	Hypsibarbus lagleri	*pa pak pe*	2nd	
3	*Scaphognathops spp.*	*pa pian*	3rd	maybe 1 or 2 spp.
4	*Puntioplites falcifer*	*pa sakang*	3rd	
5	*Morulius sp. or spp.*	*pa ee-tou*	3rd	
6	*Hemibagrus wyckioides*	*pa kheung*	1st	together with *H. filamentous*
7	*Barbodes altus*	*pa vian fai*	3rd	
8	*Discerodontus ashmeadi*	*pa hang deng*	3rd	
9	*Cyclocheilichthys sp. or spp.*	*pa doke ngieu*	3rd	
10	*Osteochilus melanopleurus*	*pa nok khao*	3rd	
11	*Channa micropeltes*	*pa ka do*	4th	
12	*Wallago leeri*	*pa khoun*	pre 1st	
13	*Pangasius larnaudii*	*pa peung*	pre 1st	
14	*Wallago attu*	*pa khao*	pre 1st	
15	*Pangasius conchophilus*	*pa pho/pa ke*	pre 1st	
16	*Pangasius macronema/ pleurotaenia*	*pa gnone*	pre 1st	
Other Species Recorded But Not Ranked				
N/A	*Channa striata*	*pa kho*	4th	
N/A	*Clarias sp or spp.*	*pa douk*	4th	
few	*Labeo erythropterus*	*pa va souang*	2nd	together with *Hypsibarbus*
N/A	*Mystus sp. or spp.*	*pa khagneng*	3rd	
N/A	*Raiamas guttatus*	*pa sanak*	3rd	
N/A	*Labiobarbus leptocheilus*	*pa lang khon*	3rd	
N/A	*Henicorhynchus sp. or spp.*	*pa soi*	3rd	
some	*Lobocheilus sp. or spp.*	*pa khiang*	3rd	

migrate at virtually the same time as *Scaphognathops bandanensis*. *S. bandanensis* arrives at Hang Khone near the very beginning of the fishery, sometimes with *Mekongina erythrospila*, although peak catches for the latter tend to be a little after those of *S. bandanensis*. Although not evident every year, *Gyrinocheilus pennocki* is generally the last fish to show up at Hang Khone, after peak catches of *Mekongina* and *Scaphognathops* have already passed.

Peak fishing periods (when the most gill nets are used) tend to be at times with relatively high CPUEs, as local fishermen rapidly increase their effort after hearing from other fishers that schools of migrating fish have arrived. However, CPUE values are often relatively high at the beginning of the season, indicating that there is a short lag time between when fish are observed, and when fishermen put out their nets.

Based on the data available, it has not been possible to conclude that overall fish catches are declining or increasing, since no definite trend could be found in increasing or declining CPUE values over the six years that the fishery was monitored (Baird and Flaherty, unpubl. data). However, the catches of one of the main species in the fishery, *Scaphognathops bandanensis*, certainly did decline as an overall proportion of catches over the years that the fishery was monitored.

Discussion

The 4-9 dry season set gill net fishery at Hang Khone largely targets a complex array of highly migratory fish species that ascend longitudinally up the Mekong River from Cambodia each year at the beginning of the dry season. Since the main species caught are not in spawning condition during the dry season, we believe that they are participating in trophic migrations, in

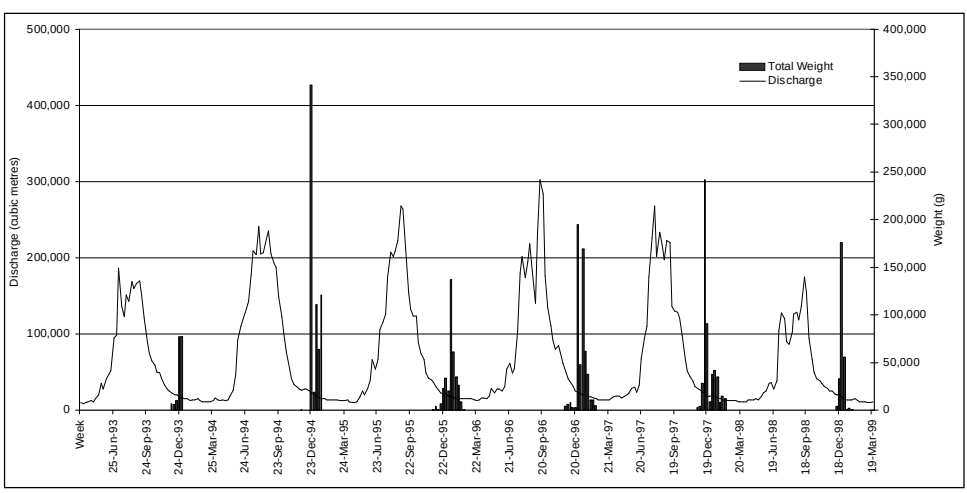

Fig. 3. 1993-1998 Weekly Mekong River discharge against weekly total catch for 4-9 cm meshed gillnet *Scaphognathops* fishery at Hang Khong Village, Khong District, Champasak Province, southern Lao PDR

which the main result is dispersal along the Mekong River to feed on algae, including filamentous chlorophytes, many being in the genus *Spirogyra* (Roberts and Warren 1994). At the beginning of the dry season, the Mekong River becomes less turbid, permitting sunlight to easily penetrate the water, promoting rapid algae growth through photosynthesis.

The origin of many of the medium sized cyprinids that we are concerned with in this paper has not been evident in the past, for example, (Poulsen and Jorgensen 2000) *Scaphognathops bandanensis, Mekongina erythrospila, Bangana behri, Hypsibarbus malcolmi, Labeo erythropterus* and *Cirrhinus molitorella,* six of the most abundant species in catches, are all either not present, or are very rare, in sections of the Mekong River south of Sambor District, Kratie Province, northeast Cambodia (Roberts and Warren 1994; Lieng et al. 1995; Baird et al. 1999; Poulsen and Jorgensen 2000). Furthermore, none have been recorded in significant numbers in bag net catches in the Tonle Sap River (Lieng et al. 1995; Van Zalinge et al. 1999).

As explained in the introduction, large numbers of fishermen believe that the six species mentioned above, as well as possibly others, migrate down the Sekong, Sesan and Srepok Rivers at the end of the rainy season, entering the Mekong River at Stung Treng town (Baird, unpubl. data). Chea and Sien (1999) have reported the same. Large numbers of fishermen interviewed by the first author claim that fish entering the Mekong River at Stung Treng town do not initially migrate upriver, but instead move about 30 km downriver to near the border between Stung Treng and Kratie Provinces, at a place known to ethnic Lao people in Cambodia at *Thong Deng,* and to ethnic Khmer people as *Tong Deng* (an apparent variation of the Lao name). The fish congregate in large numbers in this area for about three days before some turn around and migrate back up the Mekong River past Stung Treng town to the Khone Falls and onwards. Fishers living at the confluence of the Sekong River with the Mekong River near Stung Treng town report that it often takes about a half a month for fish that pass Stung Treng town while migrating downriver to return via the Mekong River from *Tong Deng* and pass the town on their way up to Laos.

We believe that the change in direction of these migrations is due to habitat preferences and fish density. The fish are presumably undertaking a trophic feeding migration, in which they distribute themselves along the Mekong River, and the rocky habitat desired by the fish is not abundant south of Sambor in Kratie Province, and therefore the fish choose not to migrate further south. They stop and feed in areas upriver from Sambor, and as more fish move down the Mekong River, fish densities at *Tong Deng* rise to levels too high for optimal feeding. Therefore, large numbers begin to move back upriver in search of good habitat that is not saturated with fish, and is suitable for algae foraging. The fish end up being dispersed in preferred dry season feeding habitats from upriver of Sambor to the Khone Falls and above. This probably leads to a gradual decline in the size of migrations as the fish move upriver.

This hypothesis is supported by the fact that the fish first arrive at the Khone Falls in large numbers, but after they have migrated up and beyond

the Khone Falls, some of the migrators remain below the Khone Falls for the duration of the dry season, indicating that the fish are distributing themselves along the river. Moreover, fishermen at Hang Khone who travel to Cambodia regularly monitor the upriver migrations of fish during the dry season, before the fish arrive at the Khone Falls. Based on the knowledge of where the fish are being caught, fishermen can predict the approximate times that fish arrive. The LEK of fishermen at the Khone Falls is extensive, and is extremely important for ensuring that fishermen are prepared for fishing over the few days when fish are abundant and passing their villages.

It is not entirely clear why there are different waves of *Scaphognathops bandanensis* and other fishes from the Sekong, Sesan and Srepok system, but it is possible that the three waves that locals in Hang Khone report (Roberts 1993) could represent a wave for each of the major rivers in the system (Sekong, Sesan and Srepok), although this hypothesis remains unconfirmed.

The majority of the fish caught in the 4-9 cm meshed set dry season gill net fishery apparently migrate from the Sekong, Sesan, and Srepok river systems, which together constitute about 19% of the total annual discharge of the Mekong River at Kratie (Halcrow 1998). However, some of the species caught in the fishery probably originate from the Great Lake and Tonle Sap River in Cambodia, and other wetlands in Cambodia and Viet Nam. The most prominent is *Cirrhinus microlepis*. Another may be the carp *Cyclocheilichthys enoplos*, which has also been recorded in the bag net fishery in the Tonle Sap River (Lieng et al. 1995). Other fish caught in the 4-9 gill net fishery that may be migrating from the Tonle Sap River and Great Lake include *Amblyrhynchichthys truncates* Cyprinidae, *Thynnichthys thynnoides* Cyprinidae, *Barbodes altus* Cyprinidae and *Sikukia sternegeri* Cyprinidae (Roberts and Baird 1995). It is likely that the larvae of at least some of these species float downstream and enter inundated wetlands to nurse over the rainy season, before migrating up from the Tonle Sap and up the Mekong River at the beginning of the dry season (Bartham and de Brito Ribeiro 1991).

Other species prominent in the 4-9 cm meshed gill net fishery are believed to be essentially stationary or only local migrants. These include the freshwater sole *Euryglossa panoides*, which is not found above the Khone Falls, but is quite abundant below the falls, the pangasid catfish, *Pangasius polyuranodon*, and the freshwater croaker, *Boesemania microlepis*.

Still other species prominent in the fishery probably migrate out of small streams at the end of the rainy season before making shorter migrations to distribute themselves along the main river. These include the silurid catfish, *Hemibagrus filamentous* and possibly the cyprinid carps, *Hypsibarbus* spp., *Puntioplites falcifer* and *Morulius* spp. They may move from tributaries like Talat stream, which flows into the Mekong River only a few km downstream from Hang Khone (Fig. 2), or from further south in Cambodia.

Talat stream, a very long tributary originating near the border between Cambodia and Thailand to the west, was blocked by a large and very

controversial stream bag net fishery at its mouth during all the years that data were collected for the 4-9 cm meshed set gill net fishery at Hang Khone. Considering that stream bag net fisheries target certain species more than others (Table 3), it seems likely that if this fishery did not exist, those species targeted would be more abundant in catches at Hang Khone. The year 1999/2000 was the first year in over a decade that a commercial bag net was not used to block Talat stream, but we were not able to monitor the fishery at Hang Khone that year. In any case, other stream bag net fisheries in northeast Cambodia are probably continuing to impact stocks of *Scaphognathops bandanensis, Hypsibarbus* spp., *Hemibagrus filamentous* and *Puntioplites falcifer*, along with other species. For example, there were a number of illegal stream bag net fisheries operating on tributaries of the Srepok River in Ratanakiri and Mondolkiri provinces in 2003. However, there is certainly some variation of species and quantities of fish, depending on individual streams.

There has been some speculation that medium sized cyprinids migrating up the Mekong River to the Khone Falls and above are influenced by lunar cycles (Singhanouvong et al. unpubl. data; Warren et al. 1998). However, data collected at Hang Khone over the six years have led us to conclude that lunar cycles have little or no influence on the migrations of most medium sized cyprinids caught in the 4-9 cm meshed set gill net fishery at Hang Khone (Baird and Flaherty, unpubl. data), except for species that also migrate from the Great Lake and Tonle Sap River (Baird et al. 2003).

Baird et al. (2003) illustrate that migrations of small species of cyprinids from the Tonle Sap Lake and the Great Lake are closely associated with lunar changes. They suggest that this is because the fish were historically influenced by tidal cycles, which affected the Tonle Sap River and Great Lake just a few thousand years ago. However, considering that *Scaphognathops bandanensis, Mekongina erythrospila, Labeo erythropterus, Hypsibarbus malcolmi, Bangana behri, Cirrhinus molitorella* and possibly others largely migrate from the Sekong, Sesan and Srepok sub-basins, there is no reason to believe that they were influenced by tidal cycles during their recent evolutionary past. Instead, they are influenced by hydrological changes. We believe that changes in water levels at the origins of migrations is probably the most critical factor affecting the timing of fish migrations from the Sekong, Sesan and Srepok Rivers. Many villagers in Laos and stream bag net operators in Cambodia have told us that fish leave streams to return to large rivers when water levels in streams decline.

Warren et al. (1998) provide useful spatial data regarding the migrations of medium-sized dry season fish up the Mekong River from Hat village in Khong District to Hatsalao village, near the provincial capital of Champasak Province, Pakse, which is about 130 km away. They found that catches of some of the species caught at Hat were also landed at Hatsalao between five and seven days later. They reported that swimming speeds varied from 19 to 26 km a day (Warren et al. 1998). However, of the important migrators caught at Hat, only *Scaphagnathops bandanensis, Mekongina erythrospila* and *Cirrhinus microlepis* were found in significant numbers at

Hatsalao (Singhanouvong et al., unpubl. data). This may have been due to fish density (Singhanouvong et al., unpubl. data; Warren et al., 1998), and if so, their findings support our hypothesis that migratory patterns are largely dependent on fish density levels and preferred habitat.

Scaphognathops bandanensis is one of the most economically and ecologically important fishes in southern Laos and northeast Cambodia. It accounts for the largest proportion of gill net catches above and below the Khone Falls (Singhanouvong et al. unpubl. data; Baird, unpubl. data; Warren et al. 1998). Therefore, it is surprising that the Mekong River Commission's Fisheries Programme has not identified it as one of its over 50 'priority species' for study within the Mekong Basin (Poulsen and Jorgensen 2000). In our view, this species is worthy of further investigations.

One of the most important trends over the six years that the 4-9 cm set gill net fishery was monitored is the change in relative catches of *Scaphognathops bandanensis* compared to *Mekongina erythrospila*. In 1993/94 *S. bandanensis* made up 77.2% of the catch, compared to just nine percent for *M. erythrospila*. However, in 1994/95, the difference began to narrow to 52.4% for *S. bandanensis* compared to 17.4% for *M. erythrospila*, and in 1995/96 *S. bandanensis* made up just 19.2% of the catch, compared to 31.1% for *M. erythrospila*. In 1996/97, *S. bandanensis* catches increased to 26.8%, but the *M. erythrospila* was still higher, making up 29.1%. In 1997/98, *S. bandanensis* made up 27.7%, compared to 21.4% for *M. erythrospila*, and finally in 1998/99, *S. bandanensis* made up just 13.9%, compared to 61.6% for *M. erythrospila*. The above statistics indicate that *S. bandanensis* catches have relatively declined over the six years, while landings of *M. erythrospila* have remained the same, or have even increased.

We believe that the above trend is associated with the behavior or each species, and fisheries in northeast Cambodia that influence the amount of fish that migrate up the Mekong River to the Khone Falls. As indicated in table 3, *Scaphognathops bandanensis* is the third most abundant species caught in stream bag net catches. At the end of the rainy season, the fish return to large rivers, including the Sekong, Sesan and Srepok Rivers in Cambodia, and the upper part of the Sekong River in Laos' Attapeu and Sekong Provinces. *Hemibagrus filamentous* and *Hypsibarbus* spp. are the only species caught with stream bag nets in greater quantities compared to *Scaphognathops*. Fishers report that very few fish trying to migrate from the streams can escape being caught in stream bag nets, since the nets are set from one side of the stream to the other, blocking all paths of escape. It therefore appears likely that the more streams are blocked with stream bag nets, the less *Scaphognathops* will be left to migrate from the Sekong, Sesan and Srepok Rivers to the Mekong River and finally up to the Khone Falls. On the other hand, *Mekongina erythropsila* rarely enter small streams, and are not caught in stream bag nets in Cambodia. They prefer to stay in rocky areas in the rivers. Therefore, the stream bag net fishery is not likely to have any noticeable impact on the species, or the numbers that migrate up to the Khone Falls from the Sekong, Sesan and Srepok Rivers.

Local reports coming from Cambodia indicate that between the mid and the end of the 1990s there was an increase in the streams in Stung Treng and Ratanakiri Provinces that were subjected to stream bag net fishing. For example, 1999/2000 was the first year that stream bag nets were set on the Ta Bok and Kampha streams, two of the largest tributaries of the Sesan River in Ratanakiri Province. Apparently, the operators came from Stung Treng, where they used to have stream bag net concessions. However, after seriously depleting the stocks during the past decade, they were looking for newer pastures along the Sesan River in Ratanakiri Province. We believe, as do numerous fishers, that these stream bag net fisheries have done considerable damage to stocks of *S. bandanensis*, and have resulted in declines in *S. bandanensis* in gill net catches at Hang Khone. Although we do not have sufficient data from Cambodia to confirm our hypothesis, and recognize that the differences in fish catches in southern Laos could be due to natural variations in fish stock abundance, the evidence that we have presented at least indicate that there are likely to be transboundary fisheries issues at play.

The stream bag net fisheries in Stung Treng, Ratanakiri and Mondolkiri Provinces are illegal, and are not officially sanctioned by the Fisheries Department in Phnom Penh. However, influential people, including local business people and soldiers, have managed to establish the fisheries through locally sanctioned concessions, in which senior provincial and district government officials have benefited from dividing up the fees paid by concessionaires. Stream bag net fishing at the mouths of large perennial streams at the end of the rainy season is illegal in Laos, and most fishermen and government officials there frown on the practice (Baird and Flaherty, unpubl. data).

There are a number of hydroelectric dams envisioned for the lower and middle Sekong, Sesan, Srepok and Mekong Rivers. All, or almost all, pose serious threats to many of the fish species caught in the 4-9 cm meshed set gill net fishery at Hang Khone, as well as many other villages (Halcrow, 1998; IRN 1999; Bakker 1999; Fisheries Office & NTFP, unpubl. data; Baird et al. 2001a; Baird et al., unpubl. data; Hirsch and Wyatt 2004). Constructing even one of those dams could lead to the decimation of one of the most important fisheries in southern Laos and northeast Cambodia, through altering hydrology patterns and blocking migratory routes regularly traveled by many fish species. The dams may also seriously disrupt the dispersion of the larvae of some species, which spawn in upriver areas before their larvae are quickly swept downriver to nursery grounds in Cambodia and Viet Nam from Laos and Thailand after pelagic spawning for some species during the rainy season (Bartham and de Brito Ribeiro 1991). These potentially serious impacts need to be considered carefully by development planners and policymakers. Already, the Yali Falls dam on the Sesan River in Viet Nam has caused serious downstream changes in the hydrological patterns and water quality of the Sesan River in Cambodia, right down to the Mekong River (Baird and Dearden 2003; Hirsch and Wyatt 2004; Fisheries Office & NTFP, unpubl. data; Baird et al. unpubl. data).

Conclusions

With pressures on natural resources in the Mekong basin steadily increasing, efforts to manage resources for future generations are critical. The 4-9 cm meshed dry season set gill net fishery is one important fishery for villagers living in Hang Khone, as it is for many other communities below and above the Khone Falls in southern Laos (Roberts 1993; Roberts and Baird 1995; Singhanouvong et al., unpubl. data; Warren et al. 1998; Baird, unpubl. data). While over 100 species of fish were recorded in the catches of this fishery over a six-year year period, about 85% were cyprinid carps. Two highly migratory species, *Scaphognathops bandanensis* and *Mekongina erythrospila* together accounted for just over half of the catch by weight. These, and *Labeo erythropterus, Bangana behri, Hypsibarbus malcolmi* and *Cirrhinus molitorella*, and possibly others, are believed to conduct trophic dispersal migrations from well over hundreds of km away in the Sekong, Sesan and Srepok basins in northeast Cambodia and southeastern Laos. However, the migratory behavior of the many other species caught in the fishery differs considerably, and some long distance migrators originate from the Great Lake and the Tonle Sap River, and other wetlands in Cambodia and Viet Nam, before moving up the Mekong River to and above the Khone Falls. As we learn more about the complex migratory patterns of Mekong fish, it is becoming increasingly clear how vulnerable so many fish stocks are to large dam construction, which can not only block migrations, but change hydrological patterns and water quality, which are essential for the life-cycles of Mekong fish.

This paper supports the need for paying more attention to the transboundary management or straddling fish stocks that move between two or more countries in the Mekong basin, since illegal stream bag net fisheries in Stung Treng, Ratanakiri and Mondolkiri Provinces, northeast Cambodia, may be impacting on some of the fish populations that are most important to the 4-9 cm meshed set gill net fishery near the Khone Falls in southern Laos. The most notably impacted species is *Scaphognathops bandanensis*, but others suspected of being impacted are *Hypsibarbus* spp., *Hemibagrus filamentous*, *Puntioplites falcifer*, and *Morulius* spp. Thus, there is an urgent need to investigate the stream bag net fisheries in more detail, and where possible, it would be prudent to discontinue these illegal fisheries until it can be demonstrated that stream mouth bag nets are not having a serious impact on fish stocks important for other fisheries. In addition, as a first step, it would be useful to set up joint committees of village fisher representatives and government officials from Laos and Cambodia to exchange information and discuss transboundary fisheries management issues of relevance. The exact compositions of these committees need to be considered in more detail by the Lao and Cambodian governments, and communities, but the committees should include local fishers from communities dependent on transboundary fisheries, as well as local and central government officials. Hopefully, these joint committees could evolve into management units for transboundary fisheries.

This represents one of the first studies in the Mekong River basin to consider the regional management issues of straddling fish stocks that move between two or more countries, (Baird et al. 2003). Transboundary management of migratory fish species is an extremely important issue for the Mekong River basin that has so far not been adequately considered.

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